PHASE I RFI/RI

ENVIRONMENTAL EVALUATION

SAMPLING AND ANALYSIS PLAN
and
FIELD SAMPLING PLAN

ROCKY FLATS PLANT
WALNUT CREEK PRIORITY DRAINAGE
(Operable Unit No. 6)

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

ENVIRONMENTAL RESTORATION PROGRAM

OCTOBER 20, 1992
(revised February 2, 1993)

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1.0 INTRODUCTION

The purpose of this document is to detail the objectives, approach, study design, and schedule for the Environmental Evaluation (EE) associated with the Phase I RCRA Facility Investigation/Remedial Investigation (RFI/RI) process for Operable Unit (OU) No. 6 -- Walnut Creek Priority Drainage at the Rocky Flats Plant (RFP). The document is being prepared in order to focus the scope of the EE Field Sampling Plan (FSP) presented in the OU 6 Phase I RFI/RI Work Plan (U.S. DOE 1992a). The approach to sampling and analysis of ecological data and to the use of data from other sampling activities associated with the OU 6 Phase I RFI/RI result from discussions with EG&G personnel and from guidance provided by the Environmental Protection Agency (U.S. EPA 1989a, 1989b, 1989c, 1992). Information and data contained in the Baseline Biological Characterization of the Terrestrial and Aquatic Habitats (Baseline Report)(U.S. DOE 1992b), the OU 6 Phase I RFI/RI Work Plan (U.S. DOE 1992a), and the Draft OU 1 Phase III RFI/RI Report (U.S. DOE 1992c). Background information on the site, a summary of existing data, a conceptual model specific to the EE, and development of data quality objectives are included to provide a basis for rationale used in developing the Sampling and Analysis Plan (SAP) detailed in Section 3.0.

Because this RFI/RI represents the initial stages of investigation at OU 6, limited data are available on contaminants present in the Individual Hazardous Substance Sites (IHSSs). Some ecological investigations were completed during summer and fall of 1991 as part of the Baseline Biological Characterization of the Terrestrial and Aquatic Habitats at Rocky Flats Plant (U.S. DOE 1992b). These data will be used to identify robust ecological impacts, if any, that may have occurred. The remaining components of the investigation require more specific information on the contaminants present.

1.1 Purpose and Scope of OU 6 Environmental Evaluation

The purpose of the OU 6 EE is to quantify existing impacts and the risk of impacts to the biotic environment resulting from exposure to contaminants originating from OU 6 source

areas. The investigation focuses on aspects of the ecosystem potentially affected by contaminants present in OU 6. The scope and the overall objectives of the EE include:

- Developing a site-specific exposure pathway conceptual model that identifies contaminant source areas, routes of contaminant transport, ecological receptors of concern, and mechanisms by which these receptors may be exposed to chemical stressors originating from OU 6 IHSSs. The conceptual model provides a framework around which field activities are designed, and will be revised as data on contamination and receptors become available.

- Identifying potential chemical stressors using historical information and data collected during soil, surface water, and sediment sampling activities associated with the OU 6 Phase I RFI/RI. The balance of the investigation will focus on the chemical stressors presenting the greatest hazard to biota. These chemicals are identified using criteria developed by EG&G and are known as contaminants of concern (COCs).

- Identifying appropriate measurement and assessment endpoints and collection of data that will allow assessment of existing impacts and risk to ecological receptors at and around OU 6. This includes collection of ecosystem, community, and population data as well as analysis of biological tissue for COCs that may bioaccumulate. Environmental media will also be tested for direct toxicity to test organisms.

- Using the data generated in the above activities to ascertain whether OU 6 contamination has resulted in impacts to biota at RFP and to assess whether these contaminants represent unacceptable risk to ecological receptors.

In order to meet the overall objectives, the following specific objectives were established for the OU 6 EE:

- Data on the composition of communities potentially affected by OU 6 contamination will be collected using the established methods described in EMAD Operating Procedures, Volume V: Ecology (EG&G 1991a). Appropriate reference areas will also be quantified in the same manner as the study areas. These data will be used to characterize the ecological communities within OU 6 area and to identify pathways and species or habitats that may be affected by OU 6 contaminants.

- Plant and animal tissue will be collected from the OU 6 area and from reference areas and analyzed for OU 6 contaminants. This analysis will be limited to chemicals that are known to bioaccumulate through absorption from environmental media (bioconcentration) or through food web interactions (biomagnification). Biological sampling sites will be collocated with soil, surface water, or sediment sampling locations so that biological endpoints can be directly correlated with contaminant concentrations.

2.0 OU 6 DETAIL

2.1 Ecological Setting

2.1.1 General Characteristics

RFP is located at an elevation of approximately 6,000 feet, just below the elevation at which plains grasslands grade abruptly into lower montane (foothill) forests (Marr 1964). The present vegetation of RFP and adjacent areas is dominated by mixed-grass prairie interspersed with various upland and lowland community types. Much of RFP is in very good ecological condition, owing to prolonged protection from grazing and other physical disturbance. Some areas, particularly in close proximity to production, storage, or disposal sites, show the effects of disturbance and are either sparsely vegetated or dominated by weedy species. The baseline report (U.S. DOE 1992b) more thoroughly describes plant communities at RFP.

As in most of the Front Range Urban Corridor, wildlife communities at RFP have been greatly influenced by the increase in human use and disturbance over the past 100 years. Most notable have been reductions in the number and diversity of ungulates (hoofed mammals) and predators. However, the relative isolation and habitat diversity of RFP have resulted in a rich animal community, especially when compared to nearby rangeland, cropland, and commercial or industrial development. The absence of domestic livestock and the proximity to large areas of open space have contributed significantly to the wildlife resources at RFP.

2.1.2 OU-Specific Characteristics

Vegetation

Plant communities within OU 6 are controlled by moisture and prior disturbance. Topographic position is the major factor influencing soil moisture. Areas along Walnut Creek are persistently moist (mesic) because of subsurface flows within the valley floor alluvium, runoff and interflow from adjacent hillsides, and inflow from RFP's water treatment facility. The stream channel itself is wet (hydric) for much of the year, although the duration of surface flow is variable. North-facing slopes within the drainage are relatively mesic because of the low angle of insolation and the retention of snow. South-facing slopes and ridgetops are not as dry (xeric) as might be expected, probably because of shallow subsurface flow through the Rocky Flats alluvium that caps the drainage divides.

Wettest areas within the stream channel are dominated by two shrub species, leadplant and coyote willow, with scattered peachleaf willows, plains cottonwoods, narrowleaf cottonwoods, and Russian-olives. Depending upon the presence of trees, these areas were mapped in the baseline study as either Bottomland Shrub or Riparian Woodland. These units also occur along the margins of the A- and B-series ponds on North and South Walnut Creeks, respectively.

Bottomland meadows just outside the riparian zone are dominated by taller grasses, such as big bluestem and switchgrass, as well as western wheatgrass, Canada bluegrass, native Kentucky bluegrass, and blue grama. Western snowberry and golden banner form dense clumps; Canada thistle and showy milkweed are locally abundant. These communities were mapped in the baseline study as Mesic Mixed Grassland, with inclusions of Short Upland Shrub (snowberry).

Mesic Mixed Grassland also dominates the north-facing and south-facing hillsides along most of the upper reaches of North Walnut Creek, South Walnut Creek, and Dry Creek, as well as the broad valley between their confluence and Indiana Street. It is by far the most extensive habitat type in OU 6. As mentioned above, this rather diverse community type varies considerably with regard to both dominant and associated species. Western wheatgrass, blue grama, side-oats grama, green needlegrass, big bluestem, little bluestem, and prairie junegrass are widespread throughout this type. Slightly moister sites, such as north-facing slopes, have a higher percentage of bluegrasses and sleepygrass, while drier sites may have more of the gramas and needle-and-thread. Cacti are abundant in the understory. The most common species are hedgehog cactus and prickly pear; ball cactus and brittle cactus are much less numerous. Yucca occur as scattered clumps, especially on drier or rockier sites. Other prevalent species include fringed sage, Louisiana sage, common sage, and wild tarragon. Common weedy species in the Mesic Mixed Grassland type include musk thistle, great mullein, Dalmatian toadflax, Klamath-weed (St. John's-wort), common evening-primrose, and small-flowered butterfly-weed.

Xeric Mixed Grassland occupies the ridgetop drainage divides within the Walnut Creek basin. This habitat type is relatively dry as a result of greater exposure to sun and wind, but persistent moisture is available at relatively shallow depths in the Rocky Flats alluvium capping the ridges. As a result, some mesophytic species such as big bluestem and little bluestem are present. Other prevalent grasses include western wheatgrass, prairie junegrass, blue grama, buffalo grass, needle-and-thread, purple three-awn, spike dropseed, mountain muhly, bottlebrush squirreltail, and Canada bluegrass. Cacti and yucca also occur, as do Louisiana sage, fringed sage, common sage, and wild tarragon.

Small inclusions of Short Marsh (especially baltic rush) and Tall Marsh (cattails) occur in scattered hydric sites, generally associated with hillside seeps or in small stands adjacent to the creeks and pond margins. Disturbed/Barren Land was mapped in some areas; most of the disturbed sites have been invaded by annual weeds, such as tumble-mustard, tansy-mustard, alyssum, prickly lettuce, diffuse knapweed, Russian-thistle, kochia, and bracted vervain. Some previously disturbed areas have been revegetated with introduced pasture grasses, especially smooth brome, crested wheatgrass, and intermediate wheatgrass.

Wildlife

The most common small mammals in OU 6 during live-trapping studies in 1991 were the deer mouse, prairie vole, meadow vole, western harvest mouse, and plains harvest mouse. Desert cottontails and thirteen-lined ground squirrels were seen in smaller numbers. Workings characteristic of the northern pocket gopher were observed on hillsides with relatively deep soil. The Mesic Mixed Grassland habitat type supported the greatest abundance and diversity of small mammals, owing to the structural complexity afforded by a mix of short and tall grasses.

Larger mammals observed within OU 6 include the coyote and mule deer. Both of these species are wide-ranging, and the mosaic of habitats within OU 6 is suitable for their use. Red foxes, raccoons, striped skunks, and long-tailed weasels also occur at RFP in habitats such as those in OU 6.

The distribution of birds in OU 6, as elsewhere, is highly dependent on habitat. Grassland communities on the ridgetops and hillsides support ground-nesting species such as vesper sparrows, grasshopper sparrows, western meadowlarks, and mourning doves. Horned larks and lark sparrows occur in smaller numbers. Wetlands along Walnut Creek support song sparrows, common yellowthroats, and red-winged blackbirds. Mature cottonwoods and peachleaf willows provide habitat for species such as northern flickers, eastern and western kingbirds, black-billed magpies, northern orioles, yellow warblers, warbling vireos, American robins, indigo buntings, blue grosbeaks, and lesser and American goldfinches. Say's phoebes,

house finches, and barn swallows feed within the OU but probably nest on buildings or other structures. Killdeer nest in short or sparse vegetation near disturbed ground or pond margins.

Wetlands along the streams and ponds support abundant song sparrows, common yellowthroats, and red-winged blackbirds. Yellow-headed blackbirds and sora rails have been observed in some of the more extensive stands of cattail but are much less common. Mature cottonwoods and peachleaf willows provide habitat for additional species, such as northern flickers, eastern and western kingbirds, black-billed magpies, northern orioles, yellow warblers, warbling vireos, American robins, indigo buntings, blue grosbeaks, and lesser and American goldfinches.

Birds of prey observed within OU 6 include American kestrels, Cooper's hawks, northern harriers, red-tailed hawks, Swainson's hawks, and great horned owls. All of these species nest on or near RFP and hunt in OU 6 during the breeding season. Raptors seen during migration or the winter include the rough-legged hawk, golden eagle, and bald eagle.

Water birds routinely seen in OU 6 include great blue herons, black-crowned night-herons, and a variety of waterfowl. The most common waterfowl on Ponds C-1 and C-2 are mallards, gadwalls, green-winged teals, blue-winged teals, Canada geese, and pied-billed grebes. Mallards and great blue herons use the stream as well as the ponds for feeding and resting.

Commonly observed reptiles in OU 6 include the bullsnake, yellow-bellied racer, plains gartersnake, common gartersnake, and prairie rattlesnake. Amphibians present in or near aquatic habitats are the northern chorus frog and Woodhouse's toad.

Aquatic Habitats

The Walnut Creek watershed contains four sub-drainages: North Walnut Creek and South Walnut Creek are the main stems of Walnut Creek; two minor, un-named drainages enter

from the north. One of the un-named drainages originates near the Present Landfill (Operable Unit No. 7). North Walnut Creek drains the northwest section of the industrial area and is impounded by the four A-series detention ponds (Figure 1). South Walnut Creek drains the southwest area of the plant site and is impounded by the five B-series detention ponds (Figure 1). The two main stems merge east of Pond A-2 and flow east to Great Western Reservoir. Another small pond is located on the main stem just east of its intersection with Indiana Street (Figure 1). Because most of the flow from the plant area is impounded in the A- and B-series detention ponds, flow in Woman Creek east of the ponds is intermittent, receiving water from occasional controlled releases from Pond A-4 and from groundwater seeps.

Although water quality throughout the lower reaches of Woman Creek is good, the restricted flow severely limits aquatic communities outside the detention ponds (U.S. DOE 1992b, 1992c). Detention ponds A-1, B-1, B-3, and B-4 exhibit relatively diverse benthic communities. Benthic communities in other ponds are relatively depauperate. Larval dipterans (Insecta: Diptera) comprise the most abundant benthic group in the ponds. The assemblage of fish in Walnut Creek is also limited by low and variable flow conditions. Fathead minnows were the only fish species found in the A- and B-series ponds.

2.1.3 Species and Habitats of Special Concern

Endangered animal species potentially present on or near RFP include the black-footed ferret, peregrine falcon, and bald eagle (EG&G 1991b, U.S. DOE 1992b). Black-footed ferrets are not known to occur in the vicinity of RFP. Critical habitat for the ferret consists of colonies of prairie dogs, which are their primary prey. Prairie dog colonies do not occur in OU 5. Bald eagles occur at RFP, generally as irregular visitors during the winter or migration seasons. No roost areas or nest sites have been documented in the RFP vicinity. Peregrine falcons probably occur as migrants, and a pair nested approximately 10 km to the northwest in 1991. It is possible that the hunting territory of the nesting peregrines could include RFP, although suitable habitat occurs closer to the nesting area.

Candidate endangered animal species of interest include the Preble's meadow jumping mouse, swift fox, Swainson's hawk, and ferruginous hawk. All of these except the swift fox have been documented at RFP during field investigations in 1991 and 1992. Specimens of Preble's meadow jumping mouse were collected in moist, shrubby habitats along Walnut Creek in both 1991 and 1992 (EG&G 1992a). Swainson's hawks nest at RFP, and the tall cottonwoods along Walnut Creek represent suitable nest sites. Ferruginous hawks are present in the region primarily during the winter, but an unmated juvenile male spent considerable time in the Woman Creek drainage during the summer of 1991.

Only one endangered plant species, the Ute (or Diluvium) lady's tresses, is potentially on or near RFP. This species was not observed during intensive field investigations in OU 5 and other reaches of Walnut Creek in 1991 or during a sitewide endangered species survey in 1992 (EG&G 1992b). The closest populations of this species are along Clear Creek to the south of RFP and near South Boulder Creek to the north (EG&G 1992b).

Other plant species of special interest at RFP are the Colorado butterfly plant, forktip three-awn, and toothcup. The Colorado butterfly plant, a candidate endangered species, generally occurs in the transition zone between hydric and mesic meadows. This species has not been reported in the vicinity of RFP, although suitable habitats are present. The forktip three-awn was reported along Woman Creek in 1973; in 1991, it was found south of the west access road. The toothcup occurs in a variety of wetland types, and its known range extends into the western edge of the Great Plains. The nearest documented occurrence is a temporary pool about 6 km east of Boulder.

Many portions of the RFP buffer zone are of ecological importance because of their prolonged protection from grazing or other disturbance. Some of the shrub community types are uncommon outside the foothills, and the tallgrass prairie species are very limited in the region. However, the only habitats with special legal status are the wetlands identified in conjunction with the National Wetlands Inventory and subsequently field checked by the U.S. Army Corps of Engineers to verify their jurisdictional status (EG&G 1990). Within OU 6, wetland areas are primarily restricted to linear wetlands along Walnut

Creek and its tributaries. However, groundwater seeps located in an area of the north-facing hillside south of Pond B-5 may also be classified as wetlands (EG&G 1990). Most of the jurisdictional wetlands are dominated by baltic rush, cattails, or bulrushes, with a variety of associated hydrophytic species.

2.2 Description of the Operable Unit

Twenty IHSSs located along or within the drainage areas of North Walnut Creek and South Walnut Creeks are included in OU 6 (IAG 1991) (Figure 1). Ten of these IHSSs are detention ponds located in the Walnut Creek drainage, including the A-series and B-series ponds. The remaining IHSSs in OU 6 are located on adjacent banks or plateau areas that ultimately drain into Walnut Creek.

The OU 6 Phase I RFI/RI Work Plan identifies the A-series ponds (IHSSs 142.1-142.4 and 142.12, Indiana Pond); the B-series ponds (IHSSs 142.5-142.9); the Sludge Dispersal Area (IHSS 141); the Soil Dump Area (IHSS 156.2); Trenches A, B, and C (IHSSs 166.1-166.3); and four spray fields (North - IHSS 167.1, Pond - IHSS 167.2, South - IHSS 167.3, and East - IHSS 216.1) as potential sources of contamination in OU 6. Two IHSSs, the Triangle Area (IHSS 165) and the Old Outfall (IHSS 143), are within the Protected Area and will be sampled during the OU 9 EE and RFI/RI.

2.3 Site Conceptual Model

A site conceptual model was developed as part of the OU 6 Phase I RFI/RI Work Plan to identify primary contaminant sources, impacted media, contaminant transport pathways, potential receptors and mechanisms for uptake by the receptors. The principal use of the site conceptual model here is to identify exposure pathways by which environmental receptors may be exposed to contaminants. Each exposure pathway consists of a contaminant source, release mechanism, transport medium, exposure route or uptake mechanism, and a receptor. An exposure pathway is not complete without each of the these five components. The conceptual model is used in conjunction with site-specific information

on contaminant source areas, topography, surface water flows, and ecological information to identify exposure points. Exposure points are the specific areas where receptors may be exposed to contaminants. Receptors are the organisms that, by virtue of proximity, behavior, and food preferences, have the potential for taking up contaminants. These include organisms that may ingest contaminated surface water and soils or vegetation and prey that have become contaminated, terrestrial organisms that burrow in contaminated soils, and aquatic organisms that may inhabit contaminated surface water or contaminated sediments and acquire contaminants by ingestion and dermal contact.

The primary source areas most important to OU 6 are the IHSSs in the upper reaches of Walnut Creek drainage and in the industrial area. Contaminated soils in these areas are subject to transport, primarily by surface runoff, downgradient to the creek. These soils may become deposited as sediment in the detention ponds, resulting in a secondary source or reservoir for further dissemination of contaminants. Many heavy metals and semivolatile organic compounds bind tightly to soil/sediment particles and become immobilized in pond sediments. Soluble contaminants may become dissolved in surface water, impacting water quality in the creek and ponds.

The key exposure pathways to be evaluated in the OU 6 EE are direct contact with contaminated soil, sediment, and surface water (Figure 2). In addition, exposure via the food web, resulting from bioconcentration and biomagnification in flora and fauna, will also be evaluated. The focus of the investigation will be the source areas and Walnut Creek west of Indiana Avenue. However, the risks due to potential for offsite transport of contaminants in surface water and sediment will also be addressed.

2.3.1 Soils

As noted previously, soils within the OU 6 IHSSs are the primary contaminant sources. Contaminants incorporated into the soil have the potential to impact downgradient soil, surface water, and sediment through erosional transport. Contamination of downgradient soils can result in creation of secondary sources of contamination. Plants take up

contaminants in soil primarily by absorption through the roots. Animals may be exposed to contaminated soil by uptake across external body surfaces, or by ingestion of soil with food items, or when grooming. Soils will be analyzed from each site from which biological tissue samples are collected.

2.3.2 Sediment

Contaminants incorporated into pond and stream sediments have the potential to impact surface water quality as well as aquatic biota through uptake, assimilation, and transfer through the food chain. Aquatic plants rooted in contaminated sediments may be exposed through the root system. Aquatic invertebrates may be exposed to sediment contaminants through ingestion of sediments or absorption of contaminants from interstitial water. Filter-feeding fish may be exposed to contaminants when they ingest sediments while feeding. Sediments in Walnut Creek and each of the detention ponds are the major exposure points for sediments.

2.3.3 Surface Water

Contaminants may enter the surface water pathway through sediment loading and subsequent release during flow periods and surface runoff due to precipitation events. The primary exposure route for aquatic animals is absorption of dissolved contaminants across external body surfaces, but contaminated water may also be ingested during feeding. The primary exposure pathway for terrestrial animals is through drinking contaminated water. The major exposure points for surface water correspond to those for sediments.

2.3.4 Flora and Fauna

Some contaminants tend to accumulate in tissues of plants and animals that are exposed to contaminated media. This process is called bioaccumulation and can result in contaminant tissue loads that become toxic to the exposed organisms. Tissue concentrations can reach levels that are potentially toxic to herbivores or predators that ingest the contaminated

organisms. Thus, this process can result in exposure of species not normally in direct contact with contaminants in abiotic media. Some contaminants, primarily hydrophobic organic compounds resistant to metabolic degradation, can accumulate through successive trophic levels. Such compounds are said to biomagnify and can result in the highest concentrations, and therefore highest exposures, to upper-level predators. Most heavy metals, the primary concern at OU 6, do not tend to biomagnify, but can bioaccumulate especially in aquatic organisms. The primary exposure points resulting from bioaccumulation include plants and small mammals along the Walnut Creek drainages as well as fish and crayfish in the streams or ponds of Walnut Creek.

2.4 Preliminary Identification of Contaminants of Concern

COCs are the chemical stressors on which the risk characterization is focused. COCs are chemical contaminants that are potentially toxic to environmental receptors and known to be present in environmental media as a result of release from a primary source. For the EE process at Rocky Flats, COCs are identified on the basis of criteria developed by EG&G specifically for assessment of ecological risk. Identification is based on three basic criteria: (1) occurrence at the site as a result of release, (2) known ecotoxicological properties, and (3) chemical concentrations and extent of contamination that could result in toxicological effects. These criteria are detailed below.

2.4.1 Occurrence

The known or suspected occurrence of a chemical in environmental media was gleaned from the following sources:

a. existing data from abiotic media (soil, water, air) or from biota, or

b. waste stream identification and disposal practices, or

c. process analyses to identify potentially hazardous substances used in large quantities, or

d. historical accounts of use or accidental releases.

The resulting list of chemicals was then evaluated for ecotoxicity and the extent of contamination at the site.

2.4.2 Ecotoxicity

For purposes of evaluating potential COCs, the ecotoxicity of a chemical was determined from its documented adverse effects on biota or potentiation of toxic effects of other chemicals. A chemical was considered for inclusion in the list of COCs if, at levels detected within the OU, it exhibits:

a. acute and chronic toxicity, including mortality and teratogenicity, or

b. sublethal toxicity, including carcinogenicity, reduced growth rates, reduced fecundity, and behavioral effects, or

c. toxicity resulting from bioaccumulation due to absorption of the chemical directly from environmental media or ingestion of contaminated food items.

This information was extracted from federal or state regulatory guidelines, chemical information databases, or the open scientific literature. The resulting list of chemicals was then evaluated for extent of contamination at the site.

2.4.3 Extent of Contamination

To support identification of a chemical as a COC, the extent of its contamination should be such that it results in significant exposure to ecological receptors. A chemical was retained in the list of COCs if:

a. it was present above natural background concentrations, and either

b. it was present above regulatory standards or ARARs, or

c. it was present above risk-based "acceptable levels", or both.

The chemical was finally identified as a COC if it also:

d. was reported in greater than five percent of the samples analyzed from OU 6 and at least one of the following characteristics:

e. it was widely distributed, or

f. it occurred in ecologically sensitive areas such as wetlands or seeps that might serve as a drinking water source for wildlife, or

g. it occurred in localized areas of high concentration ("hot spots").

"Widely distributed" is defined as the occurrence of a chemical that is not restricted to one sampling site. For the OU 6 COC selection, a chemical was categorized as widely distributed if the number of borings with hits represented at least 20 percent of the total borings analyzed for the chemical.

2.4.4 Additional Factors

Depending on physical and chemical properties, contaminants may become differentially distributed among environmental media or components within a medium. The result may

be differential bioavailability or exposure of species or populations to the contaminant. The factors affecting distribution in environmental media include but are not limited to:

- persistence, the resistance to degradation by abiotic or biotic processes;
- volatility, the tendency to be driven off in the gaseous form, thus reducing soil or water concentration;
- mobility, the degree to which a chemical migrates within or between environmental media, putting further resources at risk;
- solubility, the tendency to dissolve in aqueous media (which may affect mobility in surface water and groundwater) and to segregate into soil or sediment; and
- differential accumulation, the tendency to segregate into different environmental media or components of a single medium.

Chemicals that satisfy the above criteria of occurrence, ecotoxicity, and extent of contamination are identified as COCs. However, because the Phase I RFI/RI represents the initial stages of remedial investigation at the site, the data needed to identify COCs from many of the OU 6 EE source areas (i.e., the IHSSs) are lacking. However, chemicals were detected in surface water and sediments from Walnut Creek drainage (Table 1). Data are available for surface water and sediment sampling sites in the A- and B-series detention ponds (Tables 2 and 3). These include the potentially toxic heavy metals beryllium, cadmium, chromium, mercury, and zinc. The highest concentrations of each of these metals were detected in the upper drainages of North Walnut Creek and South Walnut Creek. Several semivolatile organic compounds, including PCBs and herbicides, were detected at relatively low levels at some sites. Radionuclides did exceed background levels in surface water, but samples from corresponding sediment sampling sites were below RFP

background. Based on these data, preliminary identification of COCs includes the chemicals listed in Table 4.

The preliminary identification of COCs for evaluating ecological risk has been made based on available data. The preliminary COCs for the OU 6 EE are beryllium, cadmium, and mercury. The COCs consist of heavy metals detected in surface water and sediment. Organic compounds are not included because the primary effect of these compounds is that they are carcinogenic in man. Carcinogenicity is not considered an ecological risk because ecological receptors are generally short-lived and populations are generally not subject to impact at the levels thus far detected in OU 6.

Data on the extent of contamination, including the probable source area and migration pathways to Walnut Creek, are needed to evaluate the probability of release from OU 6 primary source areas. In addition, data from abiotic investigations may reveal contaminants not detected in downgradient areas. Data needed for COC selection have been identified on the basis of the exposure points noted in the conceptual model and are detailed in data quality objectives (DQOs) (Section 2.5). DQOs will be addressed by sampling during either investigations of abiotic media or the EE field program. Final identification of COCs and target analytes for tissue analysis will be made when preliminary results of abiotic investigations are available in March 1993.

2.5 Data Quality Objectives

DQOs are qualitative and quantitative statements that describe the quality and quantity of data required by the RFI/RI (U.S. EPA 1987). The DQO process is divided into three stages:

- Stage 1 - Identify decision types
- Stage 2 - Identify data uses/needs
- Stage 3 - Design data collection program

Through application of the DQO process, site-specific RFI/RI goals are established and data needs are identified for achieving those goals.

2.5.1 Identification of Decision Types

Stage 1 of the DQO process includes identification and involvement of the data users, evaluation of the available data, development of conceptual models, and specification of Phase I RFI/RI objectives and data needs. A detailed explanation of these steps is provided in Section 4.0 of the OU 6 Phase I RFI/RI Work Plan (U.S. DOE 1992a). The objective of this task is to provide adequate data to facilitate the decision-making process regarding evaluation of environmental risk and remediation alternatives at RFP.

2.5.2 Identification of Data Uses/Needs

Stage 2 of the DQO process defines data uses and specifies the types of data needed to meet the project objectives. Uses of EE data applicable to this project may be categorized as follows:

- Site characterization
- Risk assessment
- Evaluation of remedial alternatives

Data needed to evaluate environmental risk were identified based on review of historical information and existing data for environmental media in OU 6 areas. Data on contaminant type and distribution are needed to (1) identify COCs, (2) estimate current and future exposure of ecological receptors to contaminants in environmental media, and (3) determine the potential for bioaccumulation and subsequent exposure of organisms in higher trophic levels. Review of available data for the site revealed that information on soils, vegetation, and small mammals are currently lacking for areas within and downgradient of the OU 6 IHSSs. Specific data needs are detailed in Table 5.

2.5.3 Design of Data Collection Program

Stage 3 of the DQO process involves preparation of the SAP. The purpose of the OU 6 SAP is to provide a study design and schedule for the Phase I Walnut Creek Drainage RI that will satisfy the DQOs. The data collection program is designed to fill the data gaps identified in Stages 1 and 2.

3.0 SAMPLING AND ANALYSIS PLAN

3.1 Study Approach and Design

The study design for the OU 6 EE is predicated on two basic questions:

(1) Has there been a chemical stressor released from the site that could be damaging to ecological receptors?

(2) Have the released stressors resulted in significant impacts to ecological receptors, or does this likelihood exist?

The first question is addressed using data and results from investigations of abiotic media from the site. The nature and extent of contamination of surficial soils, surface water, and sediment of OU 6 IHSSs and the Walnut Creek drainage are being investigated as part of the OU 6 Phase I RFI/RI. Possible contamination by radionuclides and metals is formally addressed by comparing concentrations encountered at the site to established RFP background concentrations. These background concentrations are given as the upper 95 percent confidence interval of the mean for the background areas sampled. Thus, elevated concentrations would be suggested if greater than five percent of samples from a given area exceed the RFP background limit.

If release of a potentially ecotoxic stressor is suspected, two subsequent questions are addressed. First, are the concentrations detected in the source area potentially toxic to environmental receptors? If not, then no further consideration is required. Second, what

is the potential for toxicity at exposure points downgradient of the source area? Fate and transport modeling and event-tree analysis are employed to determine the probability of toxic exposure at a given exposure point. This is a quantitative determination that will utilize source area data and estimation of transport parameters for a chemical in a given medium. Estimation of exposure concentrations will be based on concentrations of COCs in environmental media and on the frequency and duration of exposures.

If measured or estimated concentrations at exposure points are potentially toxic, possible impacts due to the exposure are assessed using three lines of evidence. First, the magnitude of the exposure at a given exposure point is assessed using the Hazard Quotient method (U.S. EPA 1989a). This method is commonly used for assessment of non-carcinogenic toxins and uses the ratio of the exposure concentration to a toxicologically-based reference concentration. Ratios greater than one indicate possible toxicity and risk due to exposure and will be characterized according to other site-specific conditions.

Second, possible ecological endpoints impacted by the contaminant are measured in the field. Each of the metals preliminarily identified as COCs for the OU 6 EE has the potential to bioaccumulate, and tissue contaminant loads will therefore be used to assess potential adverse impacts. Tissue samples will be collected from source areas, downgradient areas, and reference areas. Concentrations of contaminants in soil, surface water, or sediment will be measured at the same sites, and a statistical approach will be used to determine the correlation among tissue contaminant loads, contaminant concentrations in environmental media, and distance from source areas. If elevated contaminant concentrations have not led to increased uptake (i.e., no significant correlation between medium concentration and tissue concentration), no impact is inferred.

Potential impacts of investigative or remedial activities to species and habitats of special ecological function or legal protection will be considered pursuant to the Endangered Species Act (ESA), the Clean Water Act, or other relevant regulations. The potential presence of Ute Lady's-Tresses and Preble's jumping mouse or their preferred habitats has been addressed previously (EG&G 1991b, 1992a, 1992b). The ESA requires that any

proposed action associated with RFI/RI activities or any remedial action consider possible impacts to individuals, populations, or their habitats as well as measures taken to mitigate impacts if necessary. Preble's jumping mouse is known to occur in the Walnut Creek drainage, and suitable habitat is found along segments of North Walnut Creek and South Walnut Creek (EG&G 1992a). Ute Lady's-Tresses is not known to occur anywhere on RFP, but suitable habitat has been identified along the Walnut Creek and its tributaries. Surveys of the Walnut Creek drainage will be conducted during July 1993 in an attempt to confirm the absence or presence of Ute Lady's-Tresses in this area.

The third line of evidence is based on results from standard toxicity tests. Sediment and surface water toxicity tests will be conducted for sites in the Walnut Creek drainage, including each of the detention ponds. Results of toxicity tests will indicate whether contaminants in surface water and sediments have led to increased toxicity of these media to standard test organisms.

This study is not designed to absolutely prove the presence or absence of an effect resulting from contamination in a source area (U.S. EPA 1989b). Rather, it is intended to address this possibility using a "weight of evidence approach" based on correlations of contaminant concentrations, ecological endpoint measurements, and results of direct toxicity testing.

3.2 Tissue Sampling and Analysis

The tissue collection and analysis program for the OU 6 EE is focused on the heavy metals that tend to bioaccumulate and on surface runoff, sedimentation, and surface water transport as the primary contaminant migration pathways. The heavy metals included in the preliminary COCs are known to bioaccumulate, especially in aquatic organisms. Limited analysis of PCBs in small mammals, fish, and crayfish will also be conducted. PCB contamination in soils within the PA may have led to downgradient contamination and subsequent uptake by biota. While PCBs are not of major concern for ecological receptors, information on exposure and transport via biological pathways is desired.

Collection of samples for tissue analysis will be conducted during fall 1992. Vegetation and small mammal samples from the more upgradient IHSSs will be held until results of soil sampling are available and target analytes can be selected. Target analytes have been identified for surface water and sediments. Therefore, vegetation, small mammals, and aquatic samples collected in and around the detention ponds will be shipped for analysis immediately following fieldwork.

The target analytes identified from the pond areas and the EPA methods for analyses are listed in Table 6. PCBs will be analyzed only in samples from the upper portions of the North Walnut Creek and South Walnut Creek drainages. Heavy metals will be analyzed in biological samples collected from sites for which data on soil/sediment contaminant content are or will be available.

Analysis of whole-body contaminant loads is often done using whole, intact animals. This measure includes the contaminants in materials contained in the gastrointestinal (GI) tract that have not been assimilated into the organism's tissue. To assess this portion of the total body content, the gut contents of some samples will be removed and analyzed separately. To do this, the GI tract will be removed from mice and larger fish (approximately 25 g and larger) and the gut content will be removed. The GI tract will be analyzed with the body, and the gut content will be analyzed separately. Gut content will be analyzed for only metals content, as the amount available will not be sufficient for analysis of radionuclides. For smaller fish, such as the fathead minnow, individuals to be composited in a single sample will be held together for 24 hours in water from the site from which they were collected to allow the gut contents to clear.

3.3 Sampling Locations

3.3.1 Study Areas

OU 6 sampling sites were selected in areas that could have potentially been affected by previous disturbance and/or contamination in OU 6 but presently support or are utilized

by terrestrial or aquatic organisms. These sites are located within or adjacent to IHSSs, including areas at varying distances downgradient. Because OU 6 includes the North Walnut Creek and South Walnut Creek drainages, all major habitats within each area are represented among the sampling sites. Within each area, data collection is stratified by habitat type to minimize the possibility that apparent differences or trends are not merely related to habitat. Sampling sites for flora and fauna are located within each site. In most cases, faunal sampling will be collocated with vegetation sampling sites (Figure 1). Identification and delineation of habitats are in accordance with SOP EE.11, and location of sampling sites within each habitat follow specific procedures outlined in the appropriate taxon-specific SOPs (SOPs EE.1 - EE.10). Terrestrial sampling locations are presented in Figure 1.

Study areas for community surveys and tissue collection of vegetation, small mammals, and aquatic organisms are shown in Figure 1. Sampling sites and ecological end points for all sites, are summarized below and listed in Table 7.

Aquatic biota will be sampled from all of the A-series ponds (including Indiana Pond), B-series ponds, and Landfill Pond. Sites SW17/SED09, SW59/SED11, and SW23/SED12 will be analyzed for PCBs in addition to the other target analytes.

Vegetation sampling sites will be located at all of the OU 6 IHSSs as well as the Present Landfill in OU 7 and above Pond A-1. Vegetation samples will also be collected at several downgradient sites: along the unnamed tributary, below the confluence of North and South Walnut Creeks, and a more upland site northeast of this confluence.

Small mammal sampling sites will always be collocated with vegetation sampling sites. Small mammal tissue will be collected from three areas: above Pond A-1, at the Sludge Dispersal Area, and northeast of the confluence of North and South Walnut Creeks. Small mammal community data will be collected from the unnamed tributary, areas adjacent to Ponds A-2 and A-3, below the Walnut Creek confluence, between Ponds B-2 and B-3, adjacent to Pond B-4, and northeast of the confluence.

3.3.2 Reference Areas

The use of reference areas will focus on identifying background concentrations of metals and radionuclides in biological tissues. However, data on some community and population parameters will be collected for comparison with study area locations. Samples from the Rock Creek areas will be used to evaluate tissue levels of metals and radionuclides. Comparisons of ecological parameters are complicated by the fact that the Rock Creek area is ecologically distinct from study areas in OU 6. The study area northeast of the Walnut Creek confluence will provide a comparable area unlikely to have been contaminated.

3.4 Field Sampling Plan

The purpose of the OU 6 FSP is to provide a study design and schedule that will satisfy the DQOs described above. This FSP describes the technical approach and sampling methodology to be used as well as the location and number of sampling sites and the frequency of data collection. The schedule for completion of field activities is included in Figure 3.

The field program includes sampling for both biota and abiotic media. Ecological and tissue contaminant loads will be evaluated as part of the EE, and data on contaminant concentrations in soil, sediments, and surface water will be collected under the Phase I RFI/RI for OU 6. A summary of the Field Sampling Plan is presented in Table 7.

3.4.1 Terrestrial Sampling

3.4.1.1 Vegetation

Rationale and Endpoints. Vegetation has been or will be sampled to determine community composition and structure and to collect tissue for laboratory analysis. Collection of community data and samples will follow procedures described in SOP EE.10 (EG&G

1991a). Fall community data and tissue samples will be collected to characterize the IHSSs, several downgradient sites, and the area above Pond B-1.

Data collected along the vegetation transects will be used to assess the following ecological and analytical endpoints:

- Total plant cover
- Cover by individual species
- Richness (number of species)
- Density (for woody plants and cacti)
- Tissue contaminant load

Methods. In assessing vegetative cover, nineteen 50-m belt transects will be located within and downgradient of the IHSSs (Figure 1). Tissue sampling of the target species Louisiana sage (*Artemisia ludoviciana*) and blue grama (*Bouteloua gracilis*) will be conducted within the belt transect. Three 25-g (dry) samples of each target species will be collected from each transect.

3.4.1.2 Small Mammals

Rationale and Endpoints. Small mammal populations will be surveyed to determine habitat use and relative abundance and to collect tissue for laboratory analysis. The data will be used in development of pathway models and exposure assessment. Small mammals will be collected in accordance with the live-trapping techniques described in SOP EE.06.

For community evaluation, endpoints include:

- Species richness (number of species)
- Species composition
- Number of individuals (per 100 trap-nights)
- Mean weight

- Population structure (sex, age class, reproductive status)

Methods. Double-line transects will be used to collect community and population data for small mammals. Traplines consisting of 25 traps each will be set for four consecutive nights in the fall. Eight transects will be located within and downgradient of IHSSs (Figure 1). For tissue sampling, three replicates will be collected from each site. At least 25 g per sample will be required for tissue analysis. Because some species weigh less than 25 g, multiple individuals may be required to complete one sample.

3.4.1.3 Surficial Soil Sampling

Surficial soil samples will be collected at sites collocated with biota sampling sites. Concentrations of contaminants in soil will be compared to concentrations in biota to provide information on the availability and uptake of contaminants. Methods will follow SOP GT.08.

3.4.2 Aquatic Sampling

3.4.2.1 Benthic Macroinvertebrates

Rationale and Endpoints. Crayfish are large, aquatic invertebrates that consume a wide range of food items. They are primarily benthic (i.e., bottom dwelling) and often burrow into sediments. These habits expose crayfish to several potential sources of contamination. Crayfish are an important prey species for predaceous fish as well as mammals and birds that feed in aquatic habitats. Crayfish will be collected from 11 surface water sites and analyzed for tissue contaminant loads.

Methods. Crayfish samples will be collected using minnow traps baited with organically grown meat (SOP EE.02). Three replicates will be collected from each site, each weighing 25 g. Whole-body composite samples will be analyzed for target analytes.

3.4.2.2 Fish

Rationale and Endpoints. Fish and other aquatic organisms are continuously exposed to any contaminants dissolved in the surface water they occupy. Many metals tend to bioconcentrate in tissues by direct absorption across external body surfaces, primarily the gills. Fish may also be exposed through the food web, with predaceous species (e.g., bass) near the top of the food chains. Fish will be collected from six pond sites. Target species for tissue analysis are fathead minnows and centrarchids such as bass or green sunfish. However, sample composition and number are subject to availability.

Methods. Fish will be collected from six surface water sites using gill nets and minnow traps (SOP EE.04). Three 25-g replicates will be collected at each site.

Sediment Toxicity Testing. Standard EPA sediment toxicity testing will be conducted for each of the A- and B-series ponds. The amphipod *Hyallela azteca* and midge larvae (*Chironomidae*) will be the test organisms used. This activity is being conducted in conjunction with the surface water program at Rocky Flats and will accompany chemical analysis of sediments and water from each site.

3.5 Tissue Sample Handling and Analyses

The objective of the tissue analysis program is to ascertain the extent to which OU 6 contaminants have been taken up by flora and fauna in affected areas. Therefore, the aim of the tissue collection program is to collect biological tissue samples from populations of selected representative taxa. Three replicate samples will be collected from each vegetation transect and small mammal trapline.

Collection of samples for tissue analysis will be conducted in accordance with the procedures described in the appropriate SOP (Ecology). Disposable latex gloves will be used when handling specimens collected for tissue analysis. Gloves will be changed between sites. All animal samples collected for tissue analysis will be frozen in clean glass jars with Teflon-

lined lids. Because individual small mammals weigh less than the 25-g objective, two or three individuals will be composited to form one sample. Plant tissue will be placed in brown paper bags and allowed to air dry or will be frozen in zip-lock plastic bags. Sample holding time for metals and radionuclides is one year when frozen.

Dissection of GI tracts will be done using clean stainless-steel dissection equipment. Dissected material will not contact surfaces other than tools and sample containers. Dissection tools will be decontaminated between samples. For fish and mice, dissection will consist of removing the GI tract from the stomach posterior to the anus. Care will be taken to avoid excessive bleeding. Once removed, the GI tract will be slit longitudinally and gut contents will be gently scraped into a 25-ml glass vial. The empty GI tract will be analyzed with the whole body composite samples.

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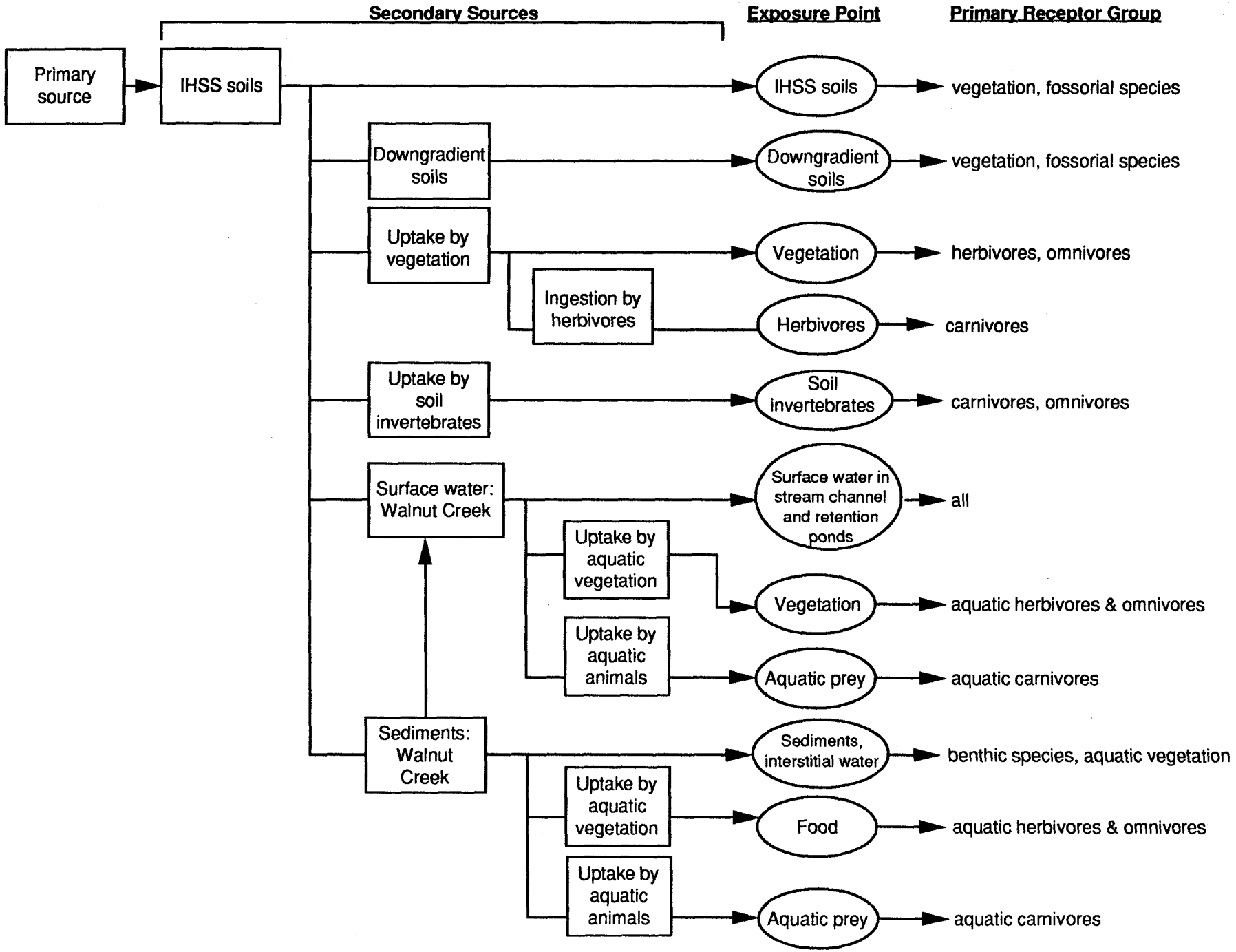

Figure 2. Conceptual Model for Primary Exposure Pathways, Operable Unit 6 Environmental Evaluation

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Figure 3. OU 6 Environmental Evaluation Project Schedule

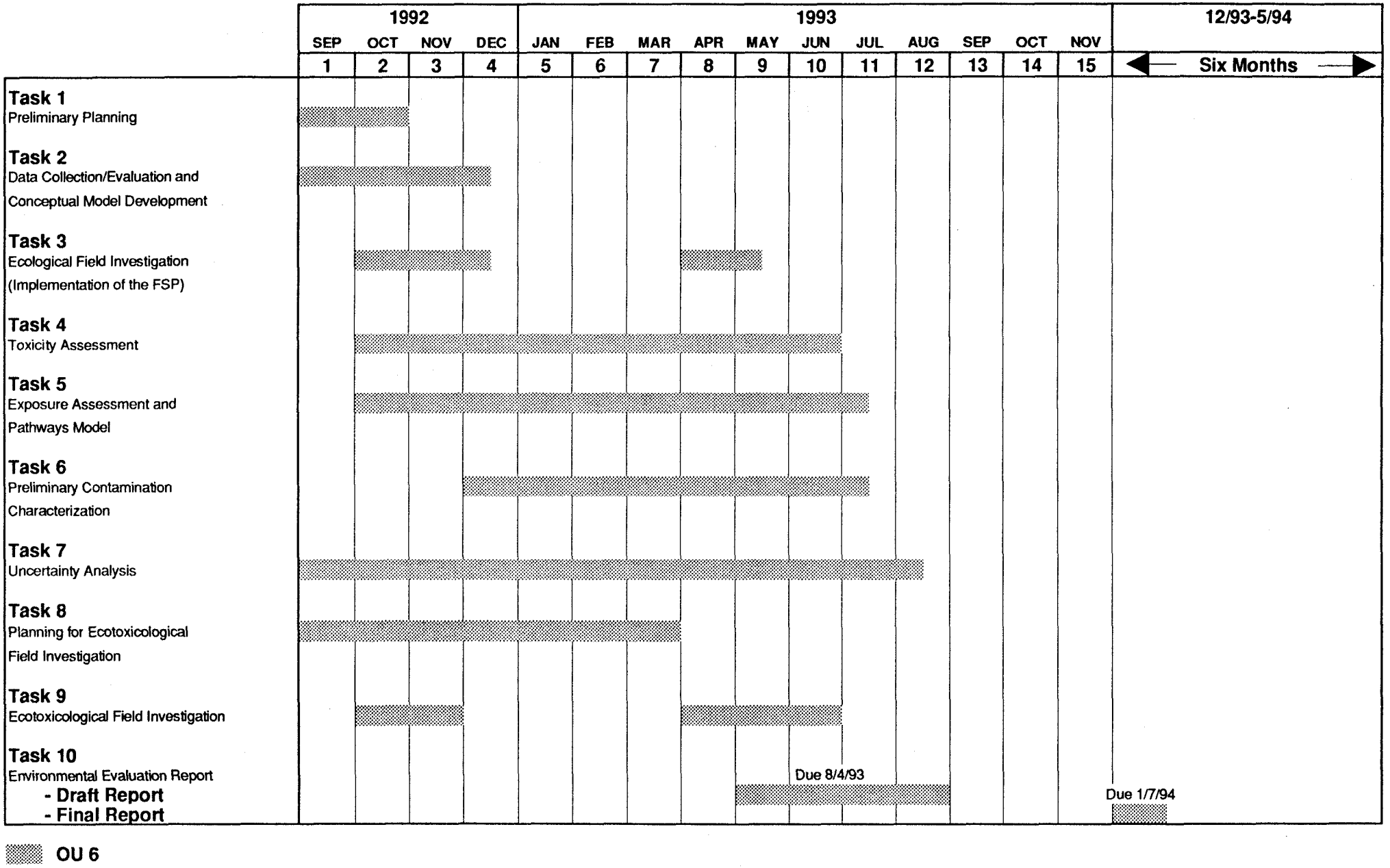

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Table 1. Chemicals Detected in Environmental Media at OU 6

Sediment
Organics[1]: acetone, fluoranthene, phenanthrene, pyrene, methylene chloride, di-n-butyl phthalate, toluene, anthracene, benzo (a) anthracene, benzo (a) pyrene, benzo (b) fluoranthene, benzo (ghi) perylene, benzo (k) fluoranthene, bis (2-ethylhexyl) phthalate, chrysene, dibenzo (a,h) anthracene, fluoranthene, indeno (1,2,3-ed) pyrene, aroclor-1254 Metals[2]: beryllium, cadmium, chromium, copper, lead, mercury, vanadium, zinc Inorganics: data not available Radionuclides[2]: americium-241, plutonium (total), strontium-40, uranium
Surface Water
Organics[1]: bis (2-ethylhexyl) phthalate, methylene chloride, 1,1,1-trichloroethane, 1,1-dichloroethane, 1,2-dichloroethane, carbon tetrachloride, chloroform, tetrachloroethane, trichloroethene, chlorobenzene, toluene, 1,2-dichloroethene, 1,1,2,2-tetrachloroethane, chloromethane, 4-methylphenol, phenol, carbon disulfide, 1,2-dimethylbenzene, 2-hexanone, chloroethane, ethylbenzene, total xylenes, n-nitrosodiphenylamine, trichloroethane, 1,1-trichloroethane, tetrachloroethene, trans-1,2-dichloropropene Metals: aluminum, beryllium, cadmium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, strontium, vanadium, zinc Inorganics: data not available Radionuclides[2]: total americium-241, plutonium-239, strontium-90, tritium, uranium-238, uranium

[1]Detected above CRQL
[2]Detected above RFP background

Table 2. Surface Water Radionuclide and Dissolved Heavy Metal Concentrations Above RFP Background Levels in OU 6, in ug/l

Site	Analyte	Reported	RFP Background
SW003	Be	90 ug/l	U5 DL ug/l
	V	313	U5 DL ug/l
	Zn	300	102
SW023	Zn	1,120	102
	Be	130	5 pCi/l
	Total Uranium	3.2 pCi/l	1.1 pCi/l
SW025	Be	20 ug/l	5 ug/l
	Total Uranium	3.3 pCi/l	1.1 pCi/l
SW059	Cr	22.2 ug/l	20 ug/l
	Cu	28.8	27
	Zn	626	102
	Total Uranium	16.6 pCi/l	1.1 pCi/l
SW060	Zn	590 ug/l	102
	Total Uranium	5.6 pCi/l	1.1 pCi/l
SW061	Zn	181 ug/l	102
	Total Uranium	5.8 pCi/l	1.1 pCi/l
SW084	Zn	133 ug/l	102 ug/l
	Americium-241	.23 pCi/l	.18 pCi/l
	Total Plutonium	6.7 pCi/l	1.1 pCi/l
SW090	Cd	171 ug/l	5 ug/l
	Cr	108	20
	Cu	184	27
	V	121	50
	Zn	1,430	102
	Americium-241	.202 pCi/l	.18 pCi/l
	Strontium 90	3.2	1.61
	Total Uranium	1023	1.1
SW092	Cd	9.9 ug/l	5 ug/l
	Zn	1,860	102
	Total Plutonium	13.93 pCi/l	1.1 pCi/l
SW093	Cr	25 ug/l	20 ug/l
	Zn	123	102
	Total Uranium	11.96 pCi/l	1.1 pCi/l
SW099	Total Uranium	20	1.1
SW100	Cu	31 ug/l	27 ug/l
	Americium-241	.33 pCi/l	.18 pCi/l
	Strontium 90	1.7	1.61
	Total Uranium	40.7	1.1

Table 2. Surface Water Radionuclide and Dissolved Heavy Metal Concentrations Above RFP Background Levels in OU 6, in ug/l

Site	Analyte	Reported	RFP Background
SW103	Americium-241 Plutonium-239	.533 pCi/l 2.8	.18 pCi/l 1.46
SW094	Cr Zn Total Uranium	56 ug/l 116 114 pCi/l	20 ug/l 102 1.1 pCi/l
SW095	Cr Total Uranium Americium-241	27 ug/l 100 pCi/l 2.2	20 ug/l 1.1 pCi/l 0.18
SW096	Total Uranium	2.5	1.1
SW097	Zn Strontium 90 Total Uranium	3,430 ug/l 2.21 pCi/l 5.5	102 ug/l 1.61 pCi/l 1.1
SW098	Cu V Zn Tritium	37 ug/l 64 498 400,000 pCi/l	27 ug/l 50 102 2,022 pCi/l
SW106	Total Uranium	216.7	1.1
SW114*	Uranium-238	1.8	0.19
SWA1	Zn Total Uranium	4,210 ug/l 2.7 pCi/l	102 ug/l 1.1 pCi/l
SWA2	Cr Hg Zn Total Uranium	22 ug/l 1.4 4,200 12.2 pCi/l	20 ug/l 1 102 1.1 pCi/l
SWA3	Zn Total Uranium	138 ug/l 6.5 pCi/l	102 ug/l 1.1 pCi/l
SWA4	Cd Cu Zn Total Uranium	18 ug/l 33 105 8.1 pCi/l	5 ug/l 27 102 1.1 pCi/l
SWB1	Total Uranium	16	1.1
SWB2	Cu Zn Total Uranium	140 ug/l 1,010 4.2 pCi/l	27 ug/l 102 1.1 pCi/l
SWB3	Zn	580 ug/l	102 ug/l
SWB4	Hg Zn Total Uranium	6.6 491 7.8 pCi/l	1 102 1.1 pCi/l

Table 2. Surface Water Radionuclide and Dissolved Heavy Metal Concentrations Above RFP Background Levels in OU 6, in ug/l

Site	Analyte	Reported	RFP Background
SWB5	Be	120 ug/l	5 ug/l
	Cd	18.8	5
	Cu	35	27
	Zn	310	102
	Total Uranium	2.1 pCi/l	1.1 pCi/l
SWLFP	Zn	890 ug/l	102 ug/l
	Total Uranium	2.1 pCi/l	1.1 pCi/l
SW016	Total Uranium	6.6	1.1
SW017	Total Uranium	6.2	1.1
SW018	Total Uranium	3.3	1.1
SW021	Be	170 ug/l	5 ug/l
	Zn	128 pCi/l	102 pCi/l
	Total Uranium	6.6	1.1

Table 3. Sediment Samples with Radionuclides and Total Heavy Metals Above Background Levels in OU 6, in ug/kg

Site	Analyte	Reported	Background
SED009	Hg	270 u/kg	110 u/kg
SED006	Hg	500	110
SED008	Hg	230	110
SED009	Hg	270	110
SED011	Be	2,500	1,210
	Zn	735,000	168,500
SED012	Hg	200	110
	Zn	258,000	168,500
SED118	Hg	500	110
SED124	Cr	44,700	25,260

Table 4. Preliminary Contaminants of Concern for the OU 6 Environmental Evaluations

Organics
semivolatile components
Metals
beryllium*, cadmium*, chromium*, copper*, lead*, mercury*, zinc*
Radionuclides
americium*, plutonium*, uranium*, strontium*

*Target analyte

Table 5. Summary of Data Quality Objectives for Operable Unit No. 6 Environmental Evaluation

Exposure Point	Data Needed	Data Exist	Data to be Collected	Data Collection Program
IHSS Vegetation	Tissue Concentration	N	Y	OU 6 RFI/RI Environmental Evaluation
IHSS Small Mammals	Tissue Concentration	N	Y	OU 6 RFI/RI Environmental Evaluation
IHSS Soils	Soil Concentration	N	Y	OU 6 RFI/RI Abiotic Sampling Program
IHSS Sediments	Sediment Concentration	N	Y	OU 6 RFI/RI Abiotic Sampling Program
IHSS Surface Water	Surface Water Concentration	Y	Y	OU 6 RFI/RI Abiotic Sampling Program
Downgradient Vegetation	Tissue Concentration	N	Y	OU 6 RFI/RI Environmental Evaluation
Downgradient Vegetation	Tissue Concentration	N	Y	OU 6 RFI/RI Environmental Evaluation
Downgradient Soils	Soil Concentration	N	Y	OU 6 RFI/RI Abiotic Sampling Program
Downgradient Sediments	Sediment Concentration	Y	Y	OU 6 RFI/RI Abiotic Sampling Program
Downgradient Surface Water	Surface Water Concentration	Y	Y	OU 6 RFI/RI Abiotic Sampling Program
Fish in IHSS Surface Water	Tissue Concentration	N	Y	OU 6 RFI/RI Environmental Evaluation
Crayfish in IHSS Surface Water	Tissue Concentration	N	Y	OU 6 RFI/RI Environmental Evaluation

Table 6. Target Analytes for the OU 6 Environmental Evaluation

Analyte	Taxa	EPA Analysis Method	Holding Times
beryllium cadmium chromium copper lead zinc	vegetation, small mammals, crayfish, fish	6010	1 year (frozen)
mercury	vegetation, small mammals, crayfish, fish	7471	28 days
PCBs	small mammals, crayfish, fish	modified 8080	14 days
radionuclides	vegetation, small mammals, crayfish, fish		1 year (frozen)

Table 7. Summary of Field Sampling Plan for Operable Unit No. 6 - Walnut Creek Priority Drainage

EE Site Code	IHSS	Sample Type	Endpoints	Sample Method	Tissue samples: Analytes	Tissue samples: # of Samples	Tissue samples: Tissue Amount	Program
TERRESTIAL SAMPLING								
Present Landfill								
VG01A7	114	Vegetation	Richness	SOP EE.10				EE
			Cover					
			Species Composition					
			Woody Plant					
			Cactus/Succulent					
			Tissue		TAL Metals	3	25 g	
MG01A7		Sm. Mammals	Richness	SOP EE.06				EE
			Species Composition					
			# Individuals					
		Soil		SOP GT.08	TAL Metals/Rads			OU7 RI
					S-VOAs			
Trench A								
VG01A6	166.1	Vegetation	Richness	SOP EE.10				EE
			Cover					
			Species Composition					
			Woody Plant					
			Cactus/Succulent					
			Tissue		TAL Metals	3	25 g	
		Soil		SOP GT.08	TAL Metals/Rads			RI
					S-VOAs			
Trench B								
VG02A6	166.2	Vegetation	Richness	SOP EE.10				EE
			Cover					
			Species Composition					
			Woody Plant					
			Cactus/Succulent					
			Tissue		TAL Metals	3	25 g	
		Soil		SOP GT.08	TAL Metals/Rads			RI
					S-VOAs			

Table 7. Summary of Field Sampling Plan for Operable Unit No. 6 - Walnut Creek Priority Drainage

EE Site Code	IHSS	Sample Type	Endpoints	Sample Method	Tissue samples: Analytes	Tissue samples: # of Samples	Tissue samples: Tissue Amount	Program
Trench C								
VG03A6	166.3	Vegetation	Richness	SOP EE.10				EE
			Cover					
			Species Composition					
			Woody Plant					
			Cactus/Succulent					
			Tissue		TAL Metals	3	25 g	
		Soil		SOP GT.08	TAL Metals/Rads			RI
					S-VOAs			
Pond Area Spray Field								
VG04A6	167.2	Vegetation	Richness	SOP EE.10				EE
			Cover					
			Species Composition					
			Woody Plant					
			Cactus/Succulent					
			Tissue		TAL Metals	3	25 g	
		Soil		SOP GT.08	TAL Metals/Rads			RI
					S-VOAs			
Unnamed Tributary								
VG05A6		Vegetation	Richness	SOP EE.10				EE
			Cover					
			Species Composition					
			Woody Plant					
			Cactus/Succulent					
			Tissue		TAL Metals	3	25 g	
MG05A6		Sm. Mammals	Richness	SOP EE.06				EE
			Species Composition					
			# Individuals					
		Soil		SOP GT.08	TAL Metals/Rads			RI
					S-VOAs			

Table 7. Summary of Field Sampling Plan for Operable Unit No. 6 - Walnut Creek Priority Drainage

EE Site Code	IHSS	Sample Type	Endpoints	Sample Method	Tissue samples: Analytes	Tissue samples: # of Samples	Tissue samples: Tissue Amount	Program
Between Parking Area and A1								
VG06A6		Vegetation	Richness	SOP EE.10				EE
			Cover					
			Species Composition					
			Woody Plant					
			Cactus/Succulent					
			Tissue		TAL Metals	3	25 g	
MG06A6		Sm. Mammals	Tissue	SOP EE.06	TAL Metals/Rads	3	??	
					PCBs	3		
		Soil		SOP GT.08	TAL Metals/Rads			RI
					S-VOAs			
Pond A2								
VG07A6	142.2	Vegetation	Richness	SOP EE.10				EE
			Cover					
			Species Composition					
			Woody Plant					
			Cactus/Succulent					
			Tissue		TAL Metals	3	25 g	
MG07A6	142.2	Sm. Mammals	Richness	SOP EE.06				EE
			Species Composition					
			# Individuals					
		Soil		SOP GT.08	TAL Metals/Rads			RI
					S-VOAs			
Pond A3								
VG08A6	142.3	Vegetation	Richness	SOP EE.10				EE
			Cover					
			Species Composition					
			Woody Plant					
			Cactus/Succulent					
			Tissue		TAL Metals	3	25 g	
MG08A6	142.3	Sm. Mammals	Richness	SOP EE.06				EE
			Species Composition					
			# Individuals					
		Soil		SOP GT.08	TAL Metals/Rads			RI
					S-VOAs			

Table 7. Summary of Field Sampling Plan for Operable Unit No. 6 - Walnut Creek Priority Drainage

EE Site Code	IHSS	Sample Type	Endpoints	Sample Method	Tissue samples: Analytes	Tissue samples: # of Samples	Tissue samples: Tissue Amount	Program
Below Confluence of Walnut Creeks								
VG09A6		Vegetation	Richness	SOP EE.10				EE
			Cover					
			Species Composition					
			Woody Plant					
			Cactus/Succulent					
			Tissue		TAL Metals	3	25 g	
MG09A6		Sm. Mammals	Richness	SOP EE.06				EE
			Species Composition					
			# Individuals					
		Soil		SOP GT.08	TAL Metals/Rads			RI
					S-VOAs			
Indiana Pond								
VG10A6	142.12	Vegetation	Richness	SOP EE.10				EE
			Cover					
			Species Composition					
			Woody Plant					
			Cactus/Succulent					
			Tissue		TAL Metals	3	25 g	
Soil Dump Area								
VG11A6	156.2	Vegetation	Richness	SOP EE.10				EE
			Cover					
			Species Composition					
			Woody Plant					
			Cactus/Succulent					
			Tissue		TAL Metals	3	25 g	
		Soil		SOP GT.08	TAL Metals/Rads			RI
					S-VOAs			

Table 7. Summary of Field Sampling Plan for Operable Unit No. 6 - Walnut Creek Priority Drainage

EE Site Code	IHSS	Sample Type	Endpoints	Sample Method	Tissue samples: Analytes	Tissue samples: # of Samples	Tissue samples: Tissue Amount	Program
East Area Spray Field								
VG12A6	216.1	Vegetation	Richness	SOP EE.10				EE
			Cover					
			Species Composition					
			Woody Plant					
			Cactus/Succulent					
			Tissue		TAL Metals	3	25 g	
		Soil		SOP GT.08	TAL Metals/Rads			RI
					S-VOAs			
Sludge Dispersal Area								
VG13A6	141	Vegetation	Richness	SOP EE.10				EE
			Cover					
			Species Composition					
			Woody Plant					
			Cactus/Succulent					
			Tissue		TAL Metals	3	25 g	
MG13A6	141	Sm. Mammals	Tissue	SOP EE.06	TAL Metals/Rads	3	25 g	
					PCBs		??	
		Soil		SOP GT.08	TAL Metals/Rads			RI
					S-VOAs			
Pond B1								
VG14A6	142.5	Vegetation	Richness	SOP EE.10				EE
			Cover					
			Species Composition					
			Woody Plant					
			Cactus/Succulent					
			Tissue		TAL Metals	3	25 g	
		Soil		SOP GT.08	TAL Metals/Rads			RI
					S-VOAs			

Table 7. Summary of Field Sampling Plan for Operable Unit No. 6 - Walnut Creek Priority Drainage

EE Site Code	IHSS	Sample Type	Endpoints	Sample Method	Tissue samples: Analytes	Tissue samples: # of Samples	Tissue samples: Tissue Amount	Program
Pond B2								
VG15A6	142.6	Vegetation	Richness	SOP EE.10				EE
			Cover					
			Species Composition					
			Woody Plant					
			Cactus/Succulent					
			Tissue		TAL Metals	3	25 g	
MG15A6	142.7	Sm. Mammals	Richness	SOP EE.06				EE
			Species Composition					
			# Individuals					
		Soil		SOP GT.08	TAL Metals/Rads			RI
					S-VOAs			
Pond B4								
VG16A6	142.8	Vegetation	Richness	SOP EE.10				EE
			Cover					
			Species Composition					
			Woody Plant					
			Cactus/Succulent					
			Tissue		TAL Metals	3	25 g	
MG16A6	142.8	Sm. Mammals	Richness	SOP EE.06				EE
			Species Composition					
			# Individuals					
		Soil		SOP GT.08	TAL Metals/Rads			RI
					S-VOAs			
Pond B5								
VG17A6	142.9	Vegetation	Richness	SOP EE.10				EE
			Cover					
			Species Composition					
			Woody Plant					
			Cactus/Succulent					
			Tissue		TAL Metals	3	25 g	
		Soil		SOP GT.08	TAL Metals/Rads			RI
					S-VOAs			

Table 7. Summary of Field Sampling Plan for Operable Unit No. 6 - Walnut Creek Priority Drainage

EE Site Code	IHSS	Sample Type	Endpoints	Sample Method	Tissue samples: Analytes	Tissue samples: # of Samples	Tissue samples: Tissue Amount	Program
Northeast of Confluences of Wanlut Creeks								
VG18A6		Vegetation	Richness	SOP EE.10				EE
			Cover					
			Species Composition					
			Woody Plant					
			Cactus/Succulent					
			Tissue		TAL Metals	3	25 g	
MG18A6		Sm. Mammals	Richness	SOP EE.06				EE
			Species Composition					
			# Individuals					
			Tissue		TAL Metals/Rads	3	25 g	
					PCBs	3	??	
		Soil		SOP GT.08	TAL Metals/Rads			RI
					S-VOAs			
AQUATIC SAMPLING								
SWLFP	114	Fish	Presence/Absence	Gill nets/ minnow traps				EE
			Tissue	Gill nets/ minnow traps	TAL Metals/Rads	3	25 g	
				Gill nets/ minnow traps	S-VOAs	3	???	
		Crayfish	Tissue	Gill nets/ minnow traps	TAL Metals/Rads	3	25 g	EE
				Gill nets/ minnow traps	S-VOAs	3	???	
		SW	Chem. Concentration	SOP SW.03	TAL Metals/Rads			OU7 RI
					S-VOAs			
		SED	Chem. Concentration	SOP SW.06	TAL Metals/Rads			OU7 RI
					S-VOAs			
SW17/SED09		Crayfish	Tissue	Minnow traps	TAL Metals/Rads	3	25 g	EE
					PCBs	3	???	
		SW	Chem. Concentration	SOP SW.03	TAL Metals/Rads			RI
					S-VOAs			
		SED	Chem. Concentration	SOP SW.06	TAL Metals/Rads			RI
					S-VOAs			

Table 7. Summary of Field Sampling Plan for Operable Unit No. 6 - Walnut Creek Priority Drainage

EE Site Code	IHSS	Sample Type	Endpoints	Sample Method	Tissue samples: Analytes	Tissue samples: # of Samples	Tissue samples: Tissue Amount	Program
SWA1	142.1	Fish	Presence/Absence	Gill nets/ minnow traps				EE
			Tissue	Gill nets/ minnow traps	TAL Metals	3	25 g	EE
					PCBs	3	???	
		Crayfish	Tissue	Gill nets/ minnow traps	TAL Metals	3	25 g	EE
					PCBs	3	???	
		SW	Chem. Concentration	SOP SW.03	TAL Metals/Rads			
					S-VOAs			
		SED	Chem. Concentration	SOP SW.06	TAL Metals/Rads			
					S-VOAs			
SWA2	142.2	Fish	Presence/Absence	Minnow traps				
			Tissue	Minnow traps	TAL Metals	3	25 g	
		Crayfish	Tissue	Minnow traps	TAL Metals	3	25 g	
				Minnow traps				
		SW	Chem. Concentration	SOP SW.03	TAL Metals/Rads			
					S-VOAs			
		SED	Chem. Concentration	SOP SW.06	TAL Metals/Rads			
					S-VOAs			
SWA3	142.3	Fish	Presence/Absence	Gill nets/minnow traps				EE
			Tissue	Gill nets/minnow traps	TAL Metals/Rads	3	25 g	EE
		Crayfish	Tissue	Gill nets/minnow traps	TAL Metals/Rads	3	25 g	EE
		SW	Chem. Concentration	SOP SW.03	TAL Metals/Rads			RI
					S-VOAs			
		SED	Chem. Concentration	SOP SW.06	TAL Metals/Rads			RI
					S-VOAs			

Table 7. Summary of Field Sampling Plan for Operable Unit No. 6 - Walnut Creek Priority Drainage

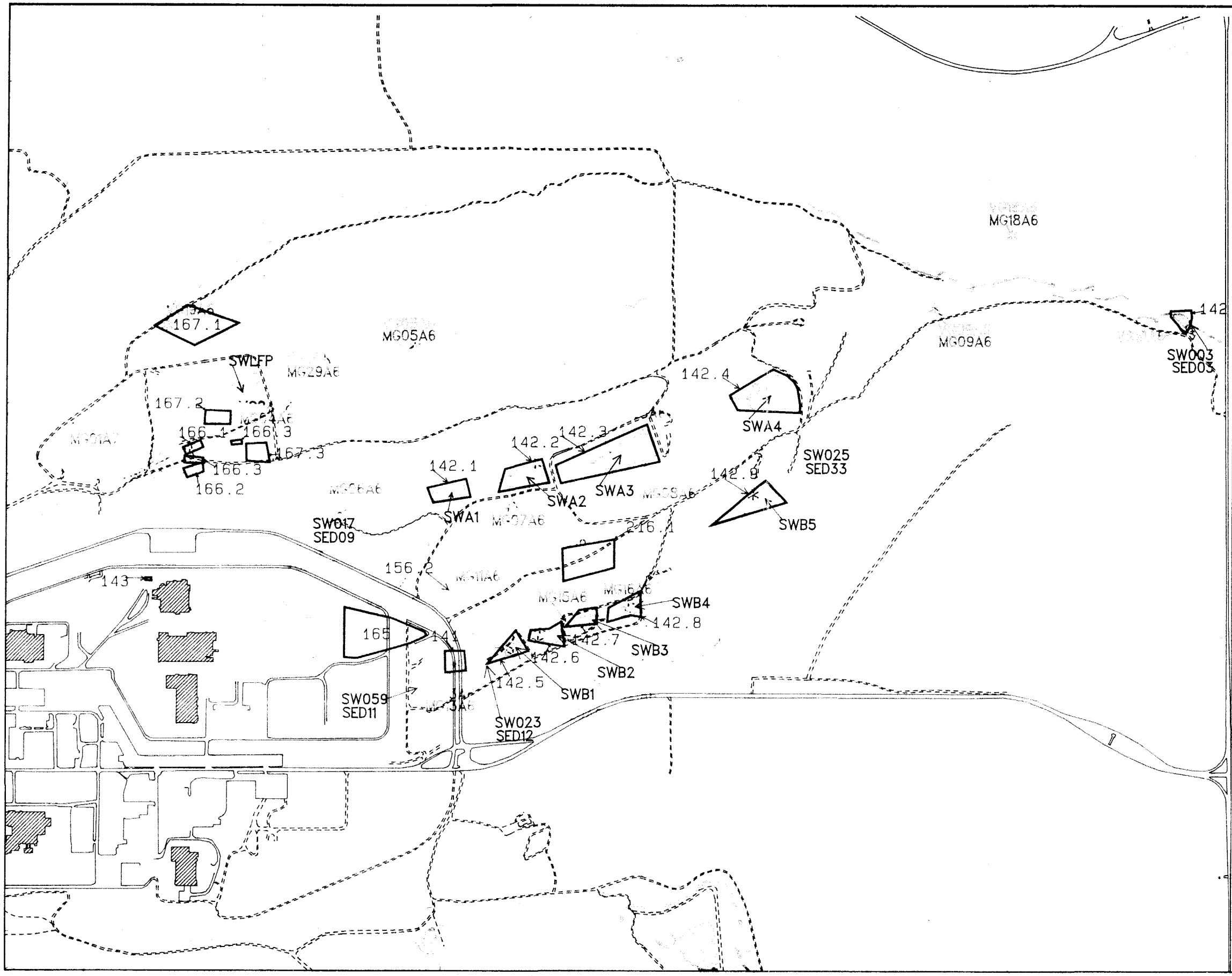
EE Site Code	IHSS	Sample Type	Endpoints	Sample Method	Tissue samples: Analytes	Tissue samples: # of Samples	Tissue samples: Tissue Amount	Program
SWA4	142.4	Fish	Presence/Absence	Gill nets/minnow traps				EE
			Tissue		TAL Metals/Rads	3	25 g	EE
		Crayfish	Tissue	Gill nets/minnow traps	TAL Metals/Rads	3	25 g	EE
		SW	Chem. Concentration	SOP SW.03	TAL Metals/Rads			
					S-VOAs			
		SED	Chem. Concentration	SOP SW.06	TAL Metals/Rads			
					S-VOAs			
SW03/SED03	142.12	Fish	Presence/Absence	Minnow traps				EE
			Tissue	Minnow traps	TAL Metals	3	25 g	EE
		Crayfish	Tissue	Minnow traps	TAL Metals	3	25 g	EE
				Minnow traps	S-VOAs	3	???	
		SW	Chem. Concentration	SOP SW.03	TAL Metals/Rads			RI
					S-VOAs			
		SED	Chem. Concentration	SOP SW.06	TAL Metals/Rads			RI
					S-VOAs			
SW59/SED 11		Crayfish	Tissue	Minnow traps	TAL Metals	3	25 g	EE
		SW	Chem. Concentration	SOP SW.03	TAL Metals/Rads			RI
					S-VOAs			
		SED	Chem. Concentration	SOP SW.06	TAL Metals/Rads			RI
					S-VOAs			
SW23/SED 12		Crayfish	Tissue	Minnow traps	TAL Metals	3	25 g	EE
		SW	Chem. Concentration	SOP SW.03	TAL Metals/Rads			RI
					S-VOAs			
		SED	Chem. Concentration	SOP SW.06	TAL Metals/Rads			RI
					S-VOAs			

Table 7. Summary of Field Sampling Plan for Operable Unit No. 6 - Walnut Creek Priority Drainage

EE Site Code	IHSS	Sample Type	Endpoints	Sample Method	Tissue samples: Analytes	Tissue samples: # of Samples	Tissue samples: Tissue Amount	Program
SWB1		Crayfish	Tissue	Minnow traps	TAL Metals	3	25 g	EE
				Minnow traps	PCBs	3	???	
		SW	Chem. Concentration	SOP SW.03	TAL Metals/Rads			RI
					S-VOAs			
		SED	Chem. Concentration	SOP SW.06	TAL Metals/Rads			RI
					S-VOAs			
SWB2		Crayfish	Tissue	Minnow traps	TAL Metals	3	25 g	EE
		SW	Chem. Concentration	SOP SW.03	TAL Metals/Rads			RI
					S-VOAs			
		SED	Chem. Concentration	SOP SW.06	TAL Metals/Rads			RI
					S-VOAs			
SWB3		Crayfish	Tissue	Minnow traps	TAL Metals	3	25 g	EE
		SW	Chem. Concentration	SOP SW.03	TAL Metals/Rads			RI
					S-VOAs			
		SED	Chem. Concentration	SOP SW.06	TAL Metals/Rads			RI
					S-VOAs			
SWB4		Fish	Presence/Absence	Minnow traps				EE
			Tissue	Minnow traps	TAL Metals/Rads	3	25 g	EE
					PCBs	3	???	
		Crayfish	Tissue	Minnow traps	TAL Metals/Rads	3	25 g	EE
					S-VOAs	3	???	
		SW	Chem. Concentration	SOP SW.03	TAL Metals/Rads			RI
					S-VOAs			
		SED	Chem. Concentration	SOP SW.06	TAL Metals/Rads			RI
					S-VOAs			

Table 7. Summary of Field Sampling Plan for Operable Unit No. 6 - Walnut Creek Priority Drainage

EE Site Code	IHSS	Sample Type	Endpoints	Sample Method	Tissue samples: Analytes	Tissue samples: # of Samples	Tissue samples: Tissue Amount	Program
SWB5		Fish	Presence/Absence	Gill nets/minnow traps				EE
			Tissue	Gill nets/minnow traps	TAL Metals/Rads	3	25 g	EE
		Crayfish	Tissue	Gill nets/minnow traps	TAL Metals/Rads	3	25 g	EE
					S-VOAs	3	???	
		SW	Chem. Concentration	SOP SW.03	TAL Metals/Rads			RI
					S-VOAs			
		SED	Chem. Concentration	SOP SW.06	TAL Metals/Rads			RI
					S-VOAs			
SW25/SED 033		Crayfish	Tissue	Minnow Traps	TAL Metals/Rads	3	25 g	EE
		SW	Chem. Concentration	SOP SW.03	TAL Metals/Rads			RI
					S-VOAs			
		SED	Chem. Concentration	SOP SW.06	TAL Metals/Rads			RI
					S-VOAs			RI



MAP LEGEND

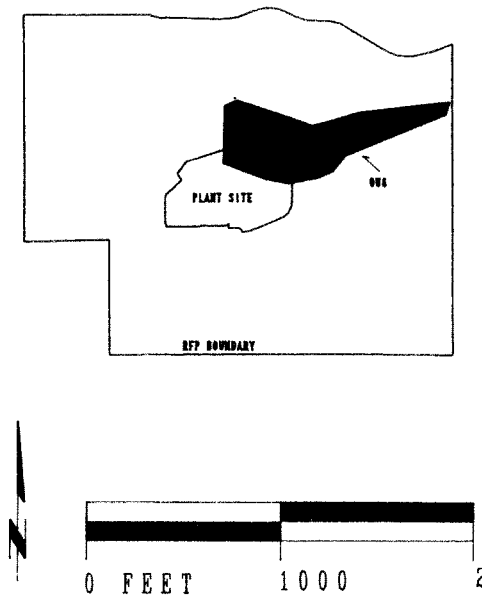
142.2 — INDIVIDUAL HAZARDOUS SUBSTANCE SITE BOUNDARIES AND IDENTIFICATION NUMBERS

STREAMS, DITCHES DRAINAGE FEATURES

PAVED ROADS

DIRT ROADS

VEGETATION AND SMALL MAMMAL SAMPLING SITES



U.S. Department of Energy

Rocky Flats Plant, Golden, CO

AQUATIC AND TERRESTRIAL SAMPLING SITES FOR OU6 ENVIRONMENTAL EVALUATION

Figure 1

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